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Enclosure (1)
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W. Schlichter
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FROM

DIE SPONTANE ELEKTRONENEMISSION GLÜHENDER METALLE

W. SCHLICHTER

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BY

CENTER FOR FOREIGN TECHNOLOGY

Chapter I

INTRODUCTION

I. The problem

For several years now, physical reactions have been associated with the name "electric glow phenomena", which differ principally in that glowing objects, especially metals, in a vacuum have the abilty to emit electrically laden parts which can be received, without the help of a promoting field, on an opposite, cooler electrode, and which can be measured as current in an outside field.

While the positive emissions, which occur especially at low temperatures and less good vacuum, in comparison fade away quickly, the negative emissons, which usually can only be observed with higgher temperatures and good vacuum, provide a picture of a temporarily fairly constant, and also otherwise defined, phenomena.
The carriers of the positive discharge are postitive ions. The remaining negative emission, after the positive has faded away, is composed only of pure electrons. These leave the metal, which is well supplied with free conducting electrons, much the same way as an evaporation process--according to the concept of the electrontheory of conducting metals--in a manner that is detremined by the nature of the metal and the temperature . (O.W. Richardson, Yearbook of Radioactivity and Electronics.)

The electrons emitted from the glowing metal charge the opposite, cooler, electrode negatively, while the glow-electrode itself, through the loss of negative elctrons, becomes positive. A difference in potential is created between the two.

When the hot and the cold electrode are connected by an outside path of conduction, the pattern in relation to this presents an element which constantly supplies the path of conductionn with energy.

This energy is created through the means of the electron-evaporation process of the source of heat, which maintains the temperature difference between the electrodes. In principle, then, there is a possibility of converting the thermal energy directly into electrical energy. Considering that a practical method of this nature would be of tremendous technical import, Professor H.Th. Simon provided me with the opportunity and the working method ~~ofxxxx~~ to research such a "glowelement" experimentally and theoretically.

II. Relation of work to the previous research

A. Spontaneous and forced function of the glowelement.--the spontaneous short circuit current

In regard to the large number of experimental tests which are presently available on electrical glow phenomena, it would seem as if the presented problem could be tackled immediately following these. But this is not the case. All the same, a number of important results of the previous research have been utilized as a basis for the present work. For the rest, it was necessry to reorient the researchmethod according to the goal of the work, at least in one point.

The research into electrical glow phenomena is usually carried out in the following way: as is figuratively shown is diagram 1a, (so as not to unnecessarily complicate the proportions, it is assumed that the electrode is not, as is usually the case, electrically heated, but is heated by irradiation), the circuit composed of heated electrode, vacuum, cold electrode and galvanometer, has a electro-motor force of such direction inserted, that it accelerates the electrons emitted by the heated electrode. A current power is derived through the function of this electomotor power, which eventually reaches the limiting value of saturation, according to the known process. As the saturation is restricted because the auxiliary field also absorbs many electrons, as are produced in the same amount oftime, the saturation current is used as a measure for the number of electrons produced by the glowing electrode in the unit of time <u>under these circumstances</u>.

These experiments, conducted according to the method of saturation, already go beyond our problem, as one can easily sea, because the glowing element, looking at it from the standpoint of energy, only acts as a consumer of energy. The glow-electric current flowing in this circle, is under pressure of the inserted auxiliary c current; we shall therefore call it a forced current, and in general will refer to a <u>forced function</u> of the glowing element.

The cell can only function as generator, in the sense of our problem, when the electrons reach the cooler opposite electrode without any outside help at all, then charge this one, and then flow back, because of the working of the automatically created difference in potential, through the outside circle to the glowing electrode. The most simple example of this is illustrated by figure Ib. It differences from diagram Ia, in that we omit the auxiliary current completely, and go directly from the endings of the electrode suppliers to the terminals of the measuring galvano meters. For the moment we will assume--which is not necessary with the saturation current method--that both the electrodes, as well as their supliers, are composed of thesame material upto the points X and Y, which are at room temperature. Thus there are no special pressuers operating in this circle. (we can neglect the very small differences in potential cuased along the suppliers by the Thomson-effect, as these amount to only about one thousandth of a volt even at temperature differences of one thousand degrees).

In this case, then, the glow-cell works entirely on its own. We shall therefore call it a <u>spontaneous function</u> of the glow-cell and call the current flowing in such a circle <u>spontaneous current</u>.

It is this spontaneous function to which we have to focus our actual interest, in contrast to previous experimentation. Next we add a comment tothe wiring of Ib. The spontaneous current flowing in this circle has the following special significance to the cases,which will be discussed later, where considerable resistance is inserted into the circuit: The total resistance, <u>w</u>, of the electrode suppliers and the measuring galvanometer, together with the very small electrical glow current i_o , produce a fall of charge of $i_o w$ ohm's, that can always be kept lower than one thousandth of a volt. Because this charge at the same time produces the difference in potential between the two electrodes, the glow-cell remains practically the same

WITH THIS CIRCUIT as when it were complete short circuited. This will become more plain in later deliberations. We therfore call the observable spontaneous current i_o of the arrangment Ib the <u>spontaneous short-circuit current</u> of the cell. It represents the real basic size of the glow-cell, and our researsch must accordingly be based on it.

F. The geometrical proportions

With the new apparatus, the total glowing area of electrode A is twenty-three square centimeters. It is practically completely surrounded by the opposite electrode B. The spontaneous short-circuit current i_o didvided by 23, leaves the short-circuit current density j_0.

With the old apparatus, the glowing electrode was on the outside, the cooler one on the inside. The geometrical proportions can be gotten from diagram 3. The measurements are given in millimeters. The glowing area A here is 4.8 square centimeters. But not all of the electrons emitted from area A can reach area B. Specifically, all those are lost which, as illustrated in croos-section diagram 4, leave A, shoot past B, and are shot into other areas of A.

To figure out in such cases what part of the emitted electrons can geometrically reach the opposite elektrode, we must start from Richardson's law regarding speed and distribution of the emitted electrons, and from that we must derive a law regarding direction and distribution. When the somewhat complicated but formal computation is figured out, the plausible result is reached:

for the electric glow emission, exactly the same law of direction and distribution is valid as for the radiation from the same area.

The radiation emitted from A, however, would reach B, under the sketched proportions, for exactly 50%. Of the total electrons emitted from A, it follows that also only half of these will reach B, or, in other words, the electrical glow area having an angle opening that reaches B is not 4.8 square centimeters, but only 2.4. Thus we keep, when using the old apparatus, the (in relation to one square centimeter of glowing area) short-circuit current density j_o, when we divide the observable short-circuit current i_o by 2.4.

A. General pattern and researchmethod

In the sofar examined short-circuit state, the executed amount of electrical work by the glow-cell was extremely small. For the cell to execute work, the electrons must, when they return via the outer circuit to the glow-electrode, have an opportunity to overcome an electrical counter voltage.

This case can be discussed using the scheme of diagram 5, with the simple assumption that this is a ohmish counter voltage. The glow-electrode is assumed to be a piece of platinum which is heated by irradiation--as in diagrams 1 a and b. This electrode is placed opposite a larger, cooler electrode which is also made of platinum. Points X and Y are the respective conducters, whose temperatures are equal to the room temperature, can be considered as the terminals of the glow-cell.

If the circuit between X and Y is made through a resistance w, and if then the electric-glow current i flows spontaneously, then the omish counter voltage i-w is created between X abd Y. The opposite charge of this equal charge between X and Y is the terminal charge K of the ceal. This is different from the differnce in potential between the electrodes, V, only through the charge decline along the supply wires to the points X and Y. For now we will assume that the resistance of the supply wires is small compared to that between X and Y, as this was the case in all previous experiments. Then too the charge decrease along the supply wires as compared to that ~~xxx~~ between X and Y is neglectable, and it is: K = V.

The experimental research of the thus sketsched cell must next be subjected to the branch of electro-technology dealing with the acceptance of charachteristics. Hereby is meant the dependance of working current i to the terminal charge K. We want to especially call this relationship the work charachteristic of glow-cells.

It combines with the spontaneous temperature charachteristic introduced in the previous chapter, and these two together are able to completely describe the mode of working of the glow-cell.

C O N C L U S I O N

Our research thus leads us to the following conclusion:

Glow-cells are principally possible. Because of the disproportionately high loss of radiation, they function completely uneconomical. But the radiation is the only cause for the impossibility of their practical application, because within the, excepting the radiation, natural laws, they work with relatively high rendability.

DIAGRAMS

Diagram la and lb

zur pumpe=to the pump

G=Galvanometer
S=Adjustable E.M.P.
A=glow-electrode
B=Opposite electrode
a=forced
b=spontaneous (short-circuited)

Diagram 5
G=Galvanometer
w=ohmish resistance
A=glow-electrode
B=opposite electrode